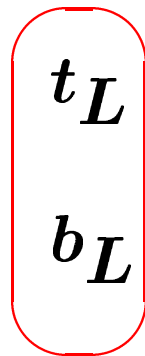

Top importance

Bogdan Dobrescu (*Fermilab*)

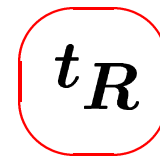


The two top quarks:

- “left-handed” top (*feels the weak interaction*)
- “right-handed” top (*no interaction with W^\pm*)



t_L
 b_L

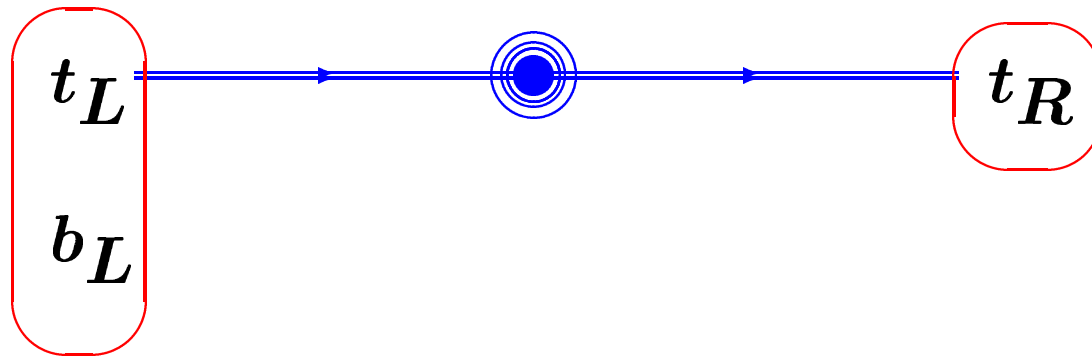


t_R

The two top quarks:

- “left-handed” top (*feels the weak interaction*)
- “right-handed” top (*no interaction with W^\pm*)

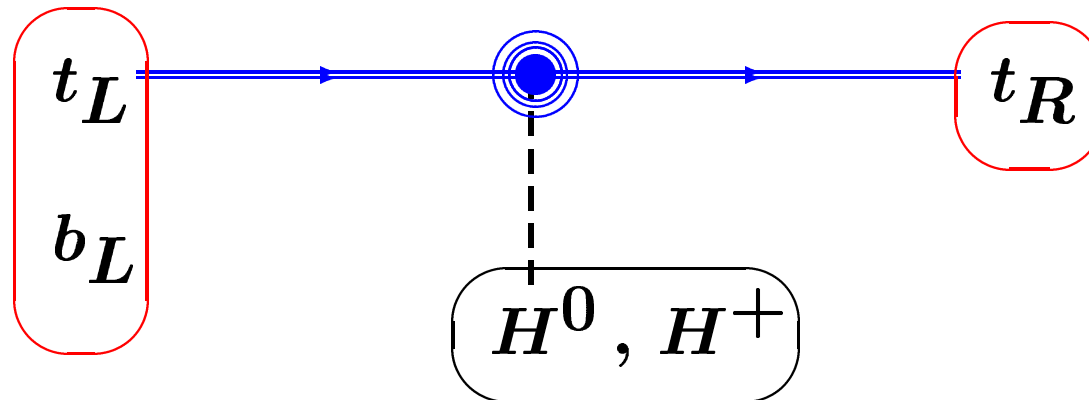
Top mass: t_L turns into t_R and vice-versa



Top quark gets a mass from its interaction
with the vacuum:

$$\lambda_t \bar{t}_R \langle H^0 \rangle t_L , \quad \langle H^0 \rangle \approx 174 \text{ GeV}$$

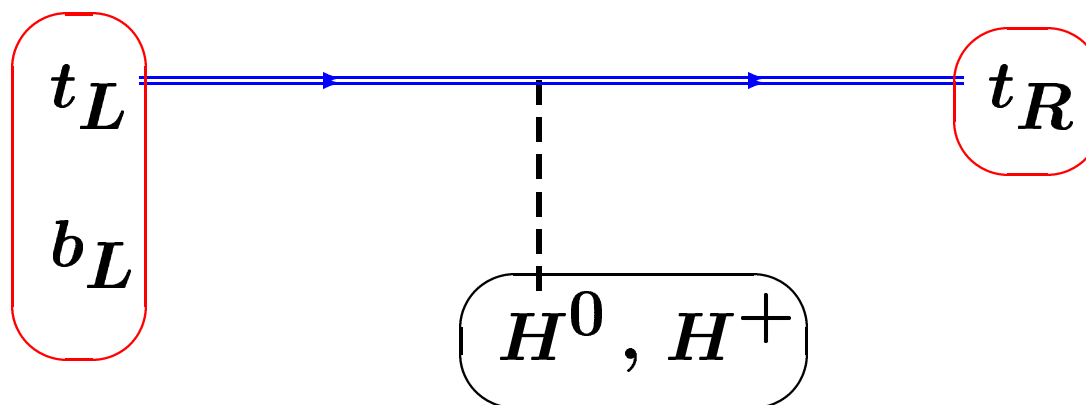
Measured top mass \Rightarrow coupling constant is $\lambda_t \approx 1$.



The coupling of the top quark to the Higgs field changes with the distance (similar to vacuum polarization in electrodynamics).

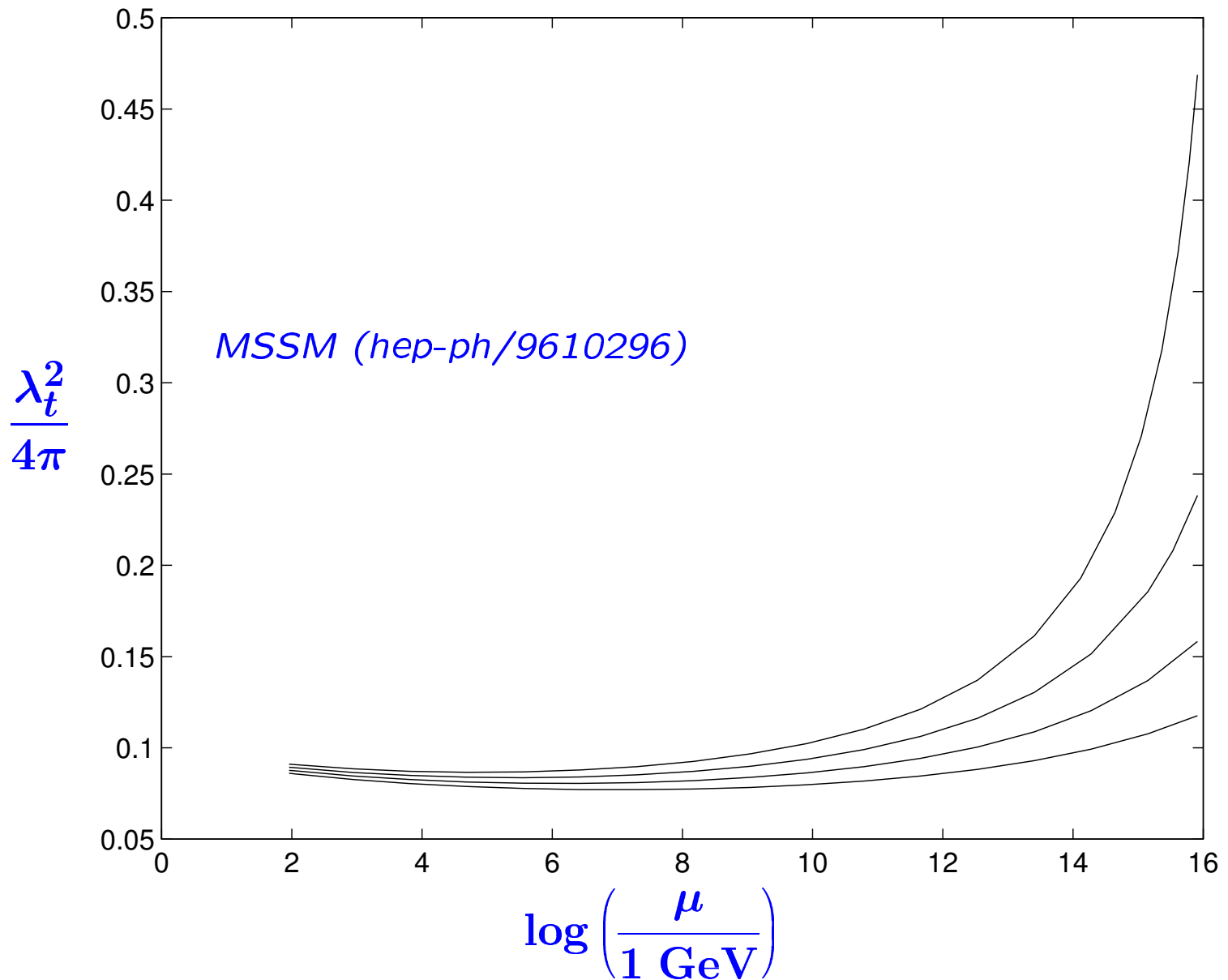
In a world of only top and Higgs:

$$\lambda_t(\mu) = \frac{\lambda_t(m_t)}{\sqrt{1 - \frac{9\lambda_t^2(m_t)}{64\pi^2} \ln \frac{\mu}{m_t}}}$$



Infrared Fixed Point for λ_t

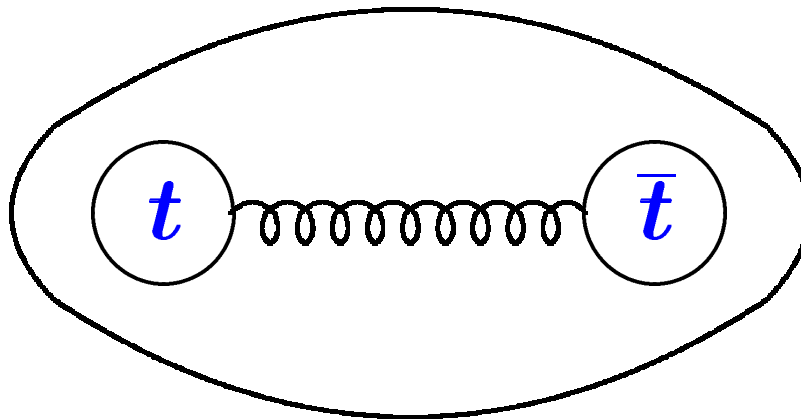
(C.T. Hill, 1981, ...)



Top condensation \Rightarrow Higgs boson is a $\bar{t}t$ bound state!

(Bardeen, Hill, Lindner, 1990, ...)

Binding may be due to some strongly-interacting heavy gauge bosons



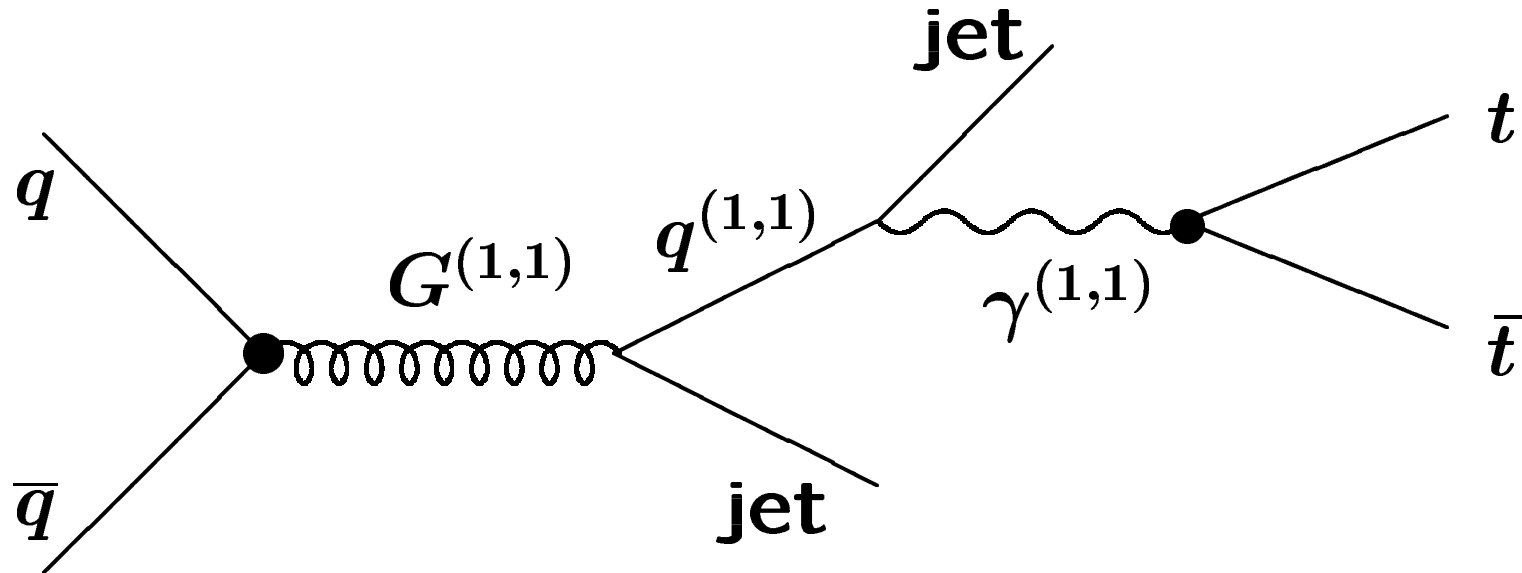
New heavy quarks (vectorlike) could accelerate the λ_t running:
scale of Higgs compositeness may be as low as a few TeV.

Explicit models: top seesaw, QCD in extra dimensions, ...

Top as a tool

Example: **standard model in 6 dimensions** (*G. Burdman, E. Ponton, B.D.*)

Gluons and photons with momentum along both extra dimensions behave as “leptophobic” s -channel resonances



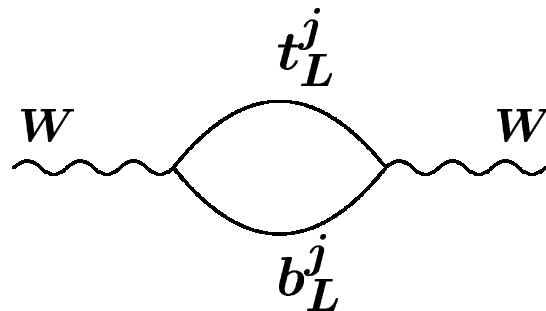
Many other examples: topcolor; $H^+ \rightarrow t\bar{b}$, ...

Top impact on electroweak observables

Example: Universal Extra Dimensions

All Standard Model particles propagate in $D \geq 5$ dimensions.

Bounds from one-loop shifts in W and Z masses, and other observables, due to Kaluza-Klein modes of the top quark



$$\frac{1}{R} \gtrsim 300 \text{ GeV}$$

Similar constraints in Little Higgs models with T-parity

(Cheng, Low, Hubisz, Meade)

Top has a strong impact on most conceivable theories on physics beyond the Standard Model

Minimal Supersymmetric Standard Model:

Higgs vacuum expectation value is induced by the large λ_t .

Higgsless models:

biggest challenge is to induce a top mass without spoiling the electroweak fits.

....

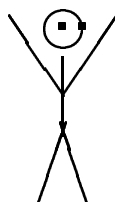
Energy



? ?

$\sim 1 \text{ TeV ?}$

New Physics



$\sim 100 \text{ GeV}$

Standard Model

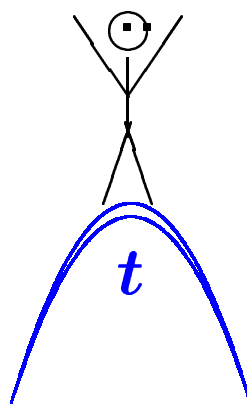
very weakly interacting particles???



Energy

$\sim 1 \text{ TeV ?}$

New Physics



$\sim 100 \text{ GeV}$

Standard Model

very weakly interacting particles???